Volume 21 May, 1935 *Number 5*

JUN 7 1935

119

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Rice Growing and Harvesting Machinery

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

This view — loaned by the Minnesota Historical Society — shows the primitive methods used by the Indians of the Northern Minnesota Lakes to gather rice.

PROGRESS IS A MATTER OF METHOD

THE primitive flail once served its purpose in the rice fields of the world — laboriously, inefficiently. Today, modern machinery handles the output of civilized countries, better, more profitably. Yet the principles haven't changed. Methods have.

And in this modernization of method, lubrication has become an important factor. Texaco *tested* Lubricants are everywhere helping operators to lower their costs of production.

Texaco Diesel Lubricants, for instance, are recommended for their clean, efficient carbon-free action. Texaco lubricated Diesels are notably free from stuck rings, and their continued fine performance with low maintenance and overhaul expense and substantial fuel savings, is characteristic.

Texaco *tested* Lubricants in the field, for all types of machinery, are proving that methods in the selection and use of lubricants are all-important in the economical operation of modern equipment.

Texaco provides a tested and proved lubricant for every purpose, and in addition brings you a friendly, helpful cooperation which, combined with your knowledge of your own operating conditions, will often save you many a dollar.

THE TEXAS COMPANY

Texaco Petroleum Products

135 E. 42nd STREET NEW YORK CITY

ATLANTA ★ BOSTON ★ BUTTE ★ CHICAGO ★ DALLAS ★ DENVER ★ LOS ANGELES
HOUSTON ★ MINNEAPOLIS ★ NEW ORLEANS ★ NEW YORK ★ NORFOLK ★ SEATTLE

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by
The Texas Company, 135 East 42nd Street, New York City
Copyright 1935 by The Texas Company
Vol. XXI May, 1935 No. 5

Change of Address: In reporting change of address kindly give both old and new addresses.
"While the contents of LUBRICATION are copyrighted, other publications will be granted permission to reprint on request, provided article is quoted exactly and credit given to THE TEXAS COMPANY."

Lubrication of Rice Growing and Harvesting Machinery

AMONG the food grains of the world, rice occupies a very prominent place. It forms a large portion of the diet of the people living in the coastal sections of many countries, especially in tropical and warm temperate climates where the water necessary for cultivation is accessible and where it can be readily diverted to the rice fields.

On portions of the Coastal Plain of the Gulf States rice is the most important grain crop grown. It is important in these areas because it can be more profitably grown on these low lands than any other crop for which there is a market in the United States. In fact, in southwestern Louisiana rice furnishes almost the only source of income. In some of the parishes (counties) in this district over 75 per cent of the cultivated land being used for rice growing.

Rice can be cultivated in all tropical climates. The greater part of the world crop, however, is grown in eastern and southeastern Asia, the principal producing countries being India, Japan and China, although large quantities are produced also in Java, Indo-China, Siam and Korea. These seven countries produce about 90 per cent of the world crop.

Outside of Asia, the principal warm temperate area of production is in the United States where about 1 per cent of the world production is grown. Of the 1,055,000 acres under rice cultivation in the United States, 555,000 acres are in southwestern Louisiana. The important natural factors which have contributed to the successful development of rice culture in this locality are suitable soils, topography, precipitation and temperature.

Soil Qualifications

Rice is more productive in soils of medium to rather heavy texture than in light loams and sandy soils. The typical rice soil of southwestern Louisiana is the Crowley silt loam. The subsoil, which lies at an average depth of 16 inches, is a mottled blue and yellow clay which is extremely suitable for this crop. The loss of irrigation water by seepage through this clay is so small as to be practically negligible.

The flatness of the surface of southwestern Louisiana permits the application of irrigation water over large tracts with a limited number of field levees. It also permits the construction of low broad levees, which offer no barriers to the use of heavy machinery in the preparation of the soil and in harvesting the crop. The tractor and threshing machine have therefore become as essential to the rice farmer as they are to the wheat grower.

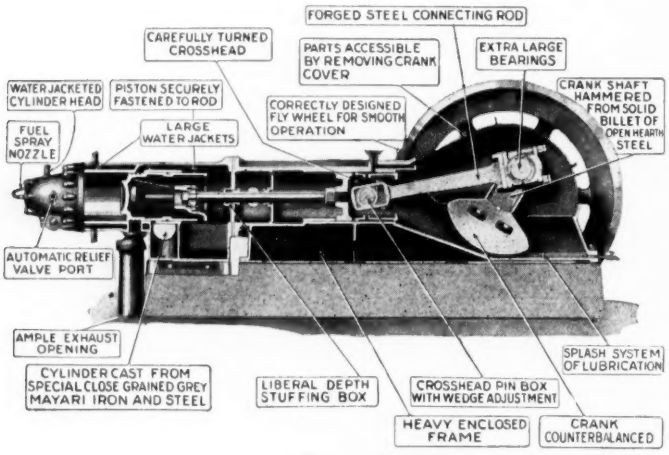
For the water required in the irrigation of the rice crop, the rice farmer must depend upon deep wells, the precipitation or rainfall over the area under cultivation and upon the watersheds of its streams. The average annual precipitation for southwestern Louisiana is about 56 inches.

The Importance of Proper Water Conditions

Temperature, as well as rainfall, is an important factor in regard to the productive ability of any rice growing area. The annual mean temperature of southwestern Louisiana is 68 degrees Fahr. The proximity of the Gulf of Mexico and the numerous streams and lakes in this part of the state seem to affect the temperature conditions to such an extent that excessive heat in summer and extreme cold in winter seldom occur.

The water required for rice production on the prairies is obtained mostly from streams and wells. Nearly 40 percent of the entire acreage in Louisiana is irrigated from deep wells. It is estimated that there are 500 pumping deep wells alone in the southwestern part of the state. These wells are drilled to an average depth of 300 to 400 feet and each will have capacity to irrigate some 300 acres. They are powered or pumped by Diesel or steam engines of various types.

The effect of water conditions upon the lubrication of these engines is of decided interest. Frequently there will be difficulty in lubricating them with the same type of oil over a wide area due to the condition and quality of the water used for injection purposes. In some instances a lubricant which would be adaptable for a certain type of engine in one locality, might be quite unsatisfactory at a point say 30 miles distant. Normally, however, a highly refined compounded mineral oil of distinctive low carbon residue characteristics will be suitable for the wet injection type of engine, the viscosity ranging from 500 to 750 seconds Saybolt at 100 degrees Fahr. An oil within the same viscosity range but without any fixed oil compound should be used for cylinders of the dry type engine of the semi-Diesel or full-Diesel type. In the crankcase, however, it is best to reduce the viscosity to the neighborhood of 300 seconds Saybolt.


FORGED STEEL CONNECTING ROD
CAREFULLY TURNED CROSSHEAD
PARTS ACCESSIBLE BY REMOVING CRANK COVER
EXTRA LARGE BEARINGS
WATER JACKETED CYLINDER HEAD
PISTON SECURELY FASTENED TO ROD
CRANK SHAFT HAMMERED FROM SOLID BILLET OF OPEN HEARTH STEEL
CORRECTLY DESIGNED FLY WHEEL FOR SMOOTH OPERATION
FUEL SPRAY NOZZLE
LARGE WATER JACKETS
AUTOMATIC RELIEF VALVE PORT
AMPLE EXHAUST OPENING
SPLASH SYSTEM OF LUBRICATION
CYLINDER CAST FROM SPECIAL CLOSE GRAINED GREY MAYARI IRON AND STEEL
LIBERAL DEPTH STUFFING BOX
CROSSHEAD PIN BOX WITH WEDGE ADJUSTMENT
HEAVY ENCLOSED FRAME
CRANK COUNTERBALANCED

Courtesy of the Chicago Pneumatic Tool Company

Fig. 1—Sectional view showing parts of the Chicago Pneumatic Giant Semi-Diesel Oil Engine. Note in particular the enclosed nature of the design which assures protection of lubrication of all external parts. The cylinders are served by a mechanical force feed lubricator having three adjustable independent feeds for each cylinder. A combination splash and flood system of lubrication is used to lubricate main bearings, crank pins, cross-head pins and cross-head guides.

Cooperative irrigation is practiced in certain parts of southwestern Louisiana, canals being operated by private companies. The water is furnished by these companies on a share or rental basis. These canals are supplied with water from the numerous streams by large pumping plants varying in size from 300 horsepower to 1500 horsepower. Some of these plants are steam driven but in most cases they employ the Diesel engine. These plants are capable of pumping as much as 750,000 gallons of water per minute for the larger plants.

Where steam power is used the compound Corliss type engine is generally preferred, of either the cross or tandem type. Steam pressure is usually around 125 pounds per square inch.

Irrigation and Soil Preparation

Irrigation is an important feature in the cultivation of rice. A depth of six inches of water must be maintained throughout a period of at least 75 days of the growing period. Water, therefore, is required in large quantities and must be available at all times during the growing season to insure maximum production. Part of this is assured by rainfall, which in Louisiana, may amount to some 20 inches during the growing season. The remaining 28 inches of the four acre feet of irrigation water usually considered necessary are obtained by pumping.

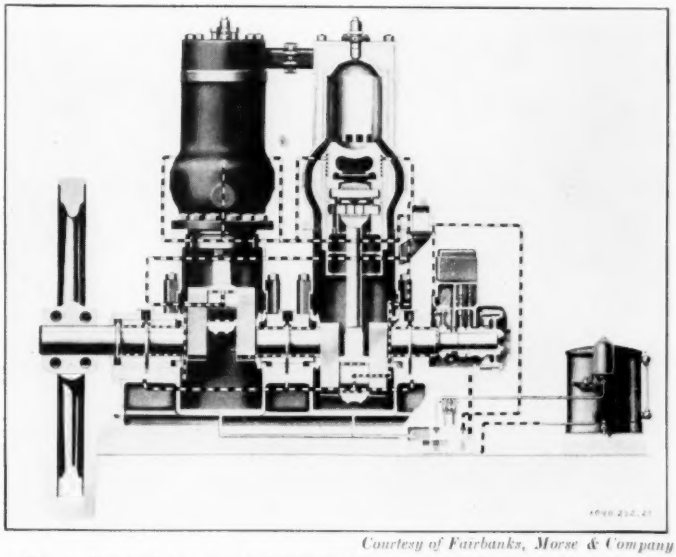
The seed bed for rice, normally, is prepared in about the same manner and with the same implements as the seed bed for other small grain crops. In other words the ground is turned over by plowing for two or three months before planting. This is done mostly by gang plows or disc plows drawn by tractors.

Just before planting the soil is broken up evenly by further disc plowing, or by harrowing. Planting takes place about March 15th to April 1st for early rice and from May 15th to June 1st for late rice. Rice is usually planted or sown with a 16-hole drill although broadcast seeders are sometimes used. These planters or drills are drawn with teams in most cases. About 80 pounds to the acre is usually planted. The average yield is ten 200-pound bags per

acre, although new land often yields as much as 22 bags per acre. The depth to which the seed is sown depends upon the condition of the seed bed. The average is about two inches.

Irrigation water usually is first applied when the young plants have reached a height of two to four inches. Sometimes the fields are allowed to get practically dry after the first water is applied, before they are replenished. The depth of water is then increased slowly until the maximum depth of six inches is obtained. Throughout the growing season the water is held at a uniform depth, fresh water being supplied when needed to equal the losses from seepage, evaporation and transpiration. Irrigation is seldom used to germinate the seed except in case of extreme dry weather after seeding.

The irrigation water is removed promptly from the rice field when the crop is ready to be harvested. This is usually from ten days to two weeks before harvest, depending on the character of the soil. The soil must then be allowed to become relatively dry and firm to permit the satisfactory use of the binder.



Courtesy of Fairbanks, Morse & Company

Fig. 2—Sectional view of the Fairbanks, Morse Model 32-E Engine which has been extensively used in rice field irrigation service. Note that lubrication is entirely automatic, as indicated on the view, and that the oil is continuously filtered. There are no oil holes or hand oiling devices to require attention; hence only an occasional inspection of the automatic system is necessary.

HARVESTING OPERATIONS

Rice is harvested in southwest Louisiana with a twine binder. As soon as it is cut, the bundles or sheaves are placed in shocks of 10 to 12 bundles. It cures in the shock where it remains if the weather is good from 10 to 14 days before it is threshed. In case of bad weather, the time is extended until it is dry enough for threshing.

In threshing rice practically the same type of machine is used as is employed in the grain fields. Rice as it comes from the thresher is known as rough rice. This latter is conveyed from the thresher in sacks of about 200 pounds capacity and stored in warehouses from which it is taken to the mill where it is prepared for the table.

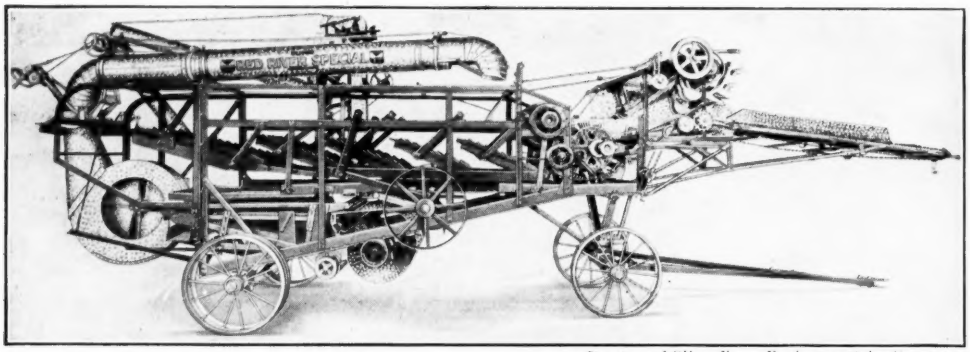
The Threshing Machine

Of the stationary or belt-driven machinery used in the rice industry, the thresher is without a doubt the most important adjunct to production, as well as being the most interesting implement to the layman. The function of the threshing machine is to remove the seed kernels from the heads of the stalks after the latter have been cut and bound by the binder. The modern thresher performs this by a beating action, somewhat similar to the historic flail, the rice-carrying stalks being passed between a series of movable and stationary beating teeth. The stationary teeth, set in "concave," serve to momentarily hold the stalks in place, while the movable teeth, which are carried on a rapidly rotating cylinder, pass between them and strike the unthreshed heads with blows of sufficient force to open the chaff and cause the kernels to loosen and separate therefrom.

In general, the modern threshing machine embodies four distinct steps in the complete shelling, separation and cleaning of the rice, i.e.:

1. Threshing—wherein the revolving cylinder and stationary "concave," with their respective teeth, serve to loosen the grains; thus the majority of the shelled kernels fall through the grates to the grain pan.
2. Separation—wherein the loosened or retained kernels are separated from the hulls or straw by means of a rotating beater which serves to push the straw back from the threshing members to the separator. A checkboard or apron is hung in back of the beater to stop the passage of flying grains, and a series of racks or parallel grates are arranged for rotary oscillation by means of suitable operating mechanisms. Thus the straw is tossed back through the machine by periodic motion. This action also jars and loosens the straw sufficiently to enable any remaining rice kernels to drop between the racks to the cleaning device.

3. Cleaning—wherein the kernels are cleaned from dirt, dust, weed seeds and chaff by passing the entire mass over suitable vibrating sieves through which a uniform blast of air is blown.



Courtesy of Oliver Farm Equipment Sales Company

Fig. 3—View showing the Oliver Red River Special Thresher and details of construction. It is especially important in the threshing of rice that the operation be carried out without cracking the kernels. This is accomplished by careful setting of the cylinder teeth. It is, of course, also important to maintain lubrication of this type of the unit in a careful manner to prevent premature wear of the operating parts.

4. Delivering—wherein the cleaned rice and straw are carried separately out from the machine by special carrier devices, such as the grain spout, weigher or wagon loader, the tailings elevator which returns grain and chaff which has not been completely threshed out back to the threshing cylinder and the wind stacker or straw handling device which carries the straw and chaff by air blast from the machine to the stack or loft.

Lubrication of the Threshing Machine

In general practice, threshing machine lubrication is usually regarded as of comparable importance with that of the Diesel engine in rice farm machinery upkeep. This is due to the dependence which is placed on the thresher during the threshing season. Any delay in operation traceable to improper lubrication, such as the occurrence of scored or burned out bearings, may frequently set back the entire working schedule so as to materially affect the net yield of the rice crop. As a result, the selection and application of suitable thresher lubricants should never be regarded as unimportant.

Threshing machines today embody a series of high speed shafts, bearings, belts, chains and pulleys. Motive power is applied to all major operating mechanisms by the simple expedient of flexible belt connections either directly or indirectly from the main driving shaft which receives its power in a similar manner from the tractor. The operator must be thoroughly impressed with the importance of these parts, and the dangers incident to the use of cheap black oils or improperly compounded grease products in which a relatively low price is the only redeeming feature. It is very true that the thresher, like all other such equipment, operates under injurious conditions, and that bearings are constantly subject to high pressures and to dust, dirt, chaff and the likelihood of being exposed to rain, but this should only be all the more reason for selecting the highest grade lubricants in order to insure as much protection as possible. In brief, the life of a thresher and its ease and efficiency of operation, will be governed to a great extent by its lubrication.

Bearings

Bearing lubrication should generally receive the most consideration, whatever means are installed for this purpose. On such parts as the cylinder bearings, automatic force feed lubricators, chain oilers or wick feed systems are extensively used. Other smaller bearings, however, will often be designed for oil cup or hand lubrication, or else provision will be made for grease. There has been a growing tendency, however, to equip the shafts of stacker blowers, cylinders and fans with roller or ball bearings, to insure dependability, in which event one should use a carefully prepared grease of medium consistency especially designed for anti-friction bearing service.

The cylinder bearings are subject to perhaps the hardest service, and hence the preference for positive means of lubrication that will not require too frequent attention. Hand lubrication, merely by the means of oil holes, is not entirely satisfactory due to the tendency towards dust accumulation. Of course such oil holes will usually be picked free from dust by the operator prior to oiling (unless they are provided with a hinged cover), yet this method of lubrication is never as dependable as the use of some form of enclosed oil cup. For bearings in general, a straight mineral engine oil having a viscosity of from 500 seconds to 750

seconds Saybolt at 100 degrees Fahr., will be most suitable. Where certain thresher builders prefer grease lubrication they will equip their machines accordingly with either compression grease cups or some pressure lubricating system. Where grease is required, a light or medium grade of product, free from acid or alkali, should be used, the body depending upon weather conditions and the means of lubrication.

Compounds of a relatively light mineral oil and cheap, poorly refined soaps should never be depended upon for such service. Not only may the petroleum constituent of such compounds be so light as to have considerable tendency toward evaporation, especially at the shaft ends where exposed to the air, but also there will be tendency towards separation with accumulation of soap or gum deposits which might cause overheated bearings and an increase in power consumption.

Courtesy of The Massey-Harris Company

Fig. 4—Sectional view of the new Massey-Harris Combined Reaper-Thresher showing travel of the straw and manner in which the rice kernels are separated therefrom. This unit is extensively equipped with anti-friction bearings.

Gear Assemblies

Lubrication of certain of the gears, sprockets and chains involved on the thresher will frequently be subject to considerable discussion. Some operators suggest that these be run dry due to the excess of dust, dirt and straw that will always be present. Such chains usually consist either of stamped steel or malleable iron links without rollers or pins. Thus the application of a gear lubricant would in some cases cause straw, dirt and dust to accumulate to such an extent as to hamper the operation of the chains, or even throw them off the sprockets. On the other hand, absence of lubrication will lead to abnormal wear. So other operators feel that if chains are removed periodically, cleaned thoroughly in kerosene, dried, and dipped in warm lubricating oil it will be more in the interest of increasing their dependability. This is an effective means of lubrication provided the chains are drained prior to replacement on the sprockets.

Cylinder Balance

In thresher operation it is essential to maintain the revolving threshing cylinder in practically perfect balance at all times. Otherwise, considerable vibration and pounding will occur which will tend to cause flat journals, worn and overheated bearings, and increased power consumption. Such a condition cannot be remedied by using a heavier grade of lubricant, although the detrimental results will be somewhat postponed. The only solution is to balance the cylinder carefully by removing it from the thresher and testing with the journals supported by horizontal knives, or straight-edges. As the cylinder rolls on its supports with the tendency of the heavier parts to turn downward, the lighter side can be weighted to bring back the balance as necessary. The usual reasons for a cylinder being out of balance are the wearing of teeth or the renewal of others irregularly without regard to the distribution of weight. On the other hand, cylinder journal boxes should not be set up too tightly, otherwise friction, power consumption, and overheating will increase markedly, leading ultimately to burned out bearings.

Belt Adjustment

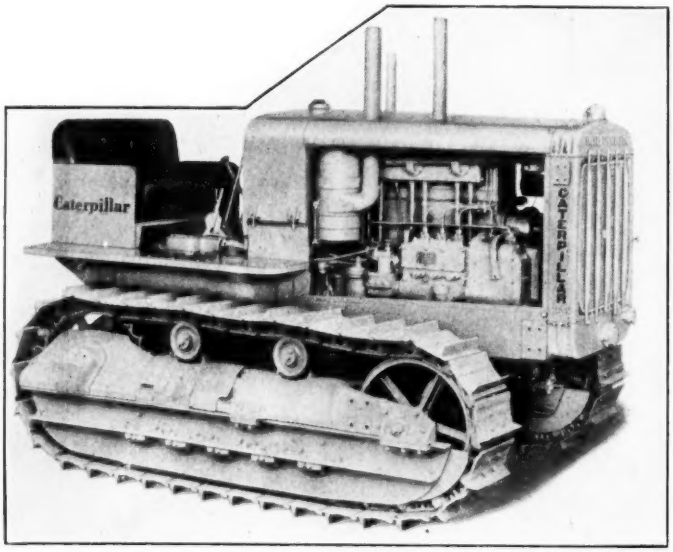
Overheating of stacker fan bearings and belt tightener bearings when they are of the plain babbitted type is oftentimes encountered and seemingly impossible of being overcome by increasing the rate of lubrication. In such cases, the tightness of the driving belt is usually the real key to the situation. An abnormally tight belt will most surely cause such bearings to run hot. However, this is no reason for running with a belt so loose as to cause slipping. Judgment in regulating the tightener pulley, and regular attention to lubricating equipment will prove the best insurance against overheating of such bearings.

TRACTOR LUBRICATION

In rice field operations the tractor must function not only as a draw-bar unit whereby plowing and cultivating machinery is handled, but also as the power plant for the threshing machine. The tractor has definitely proved its value in mass production. On the other hand, in such service loads and speed conditions are so exacting that the slightest defect in the lubricating system, or the use of an unsuitable lubricant may cause trouble. For this reason tractor lubrication must be given careful study.

The tractor is an automotive vehicle in that it involves an internal combustion engine,

along with certain other parts such as the transmission, rear end and wheel bearings. The duty to which it may be exposed, however, is often far more severe than in motor truck or automobile operation, and yet it is so carefully designed that when properly lubricated it will function quite effectively even when attended by the most inexperienced laborer.



Courtesy of Caterpillar Tractor Company

Fig. 5—View of the "Caterpillar" Diesel-35 Tractor showing relative location of the power plant with respect to operating mechanisms and tractor elements.

Engine Lubricating Systems

Standardization of design in planning the lubrication of a tractor engine has given consideration to both circulating force feed and splash oiling systems, according to the particular type involved. The tractor designer has departed from automotive practice, however, to the extent of also giving consideration to the adaptability of the mechanical force feed lubricator.

Circulating systems, of course, involve continued usage of the oil in the crank case over the life of the particular oil. In the case of the mechanical force feed oiler, continuous delivery of fresh oil to the cylinders and bearings is attained.

The full pressure system of lubrication is preferred by many in view of the fact that a sufficient amount of oil is assured to all moving parts when the engine is running, and no oil is wasted or discarded until its lubricating value has been so reduced as to render this advisable. In this system the oil is forced to the various engine parts to be lubricated, under positive pressure by means of a suitable pump (usually of the geared type), which is located in the oil reservoir.

Splash lubrication by oil from the reservoir in the crankcase is a somewhat simpler means of bringing about effective lubrication of engine parts, the oil circulating back to the reservoir by gravity for re-usage.

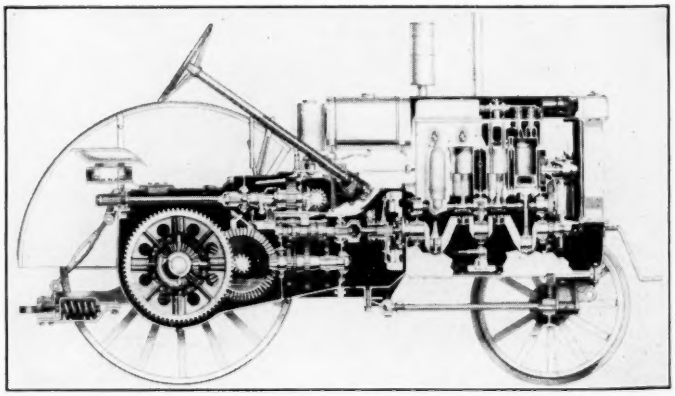
From the viewpoint of engine hours operated this oil should be changed every 40 to 60 hours when using gasoline as a fuel; or every 30 to 40 hours when using kerosene.

Operating Conditions

When selecting an oil for any particular type of lubricating system, it is especially essential that one know in advance just how the oil will act on starting, and also the degree to which it will lend itself to complete circulation and maintenance of a protective film between the wearing elements, when subjected to the bearing pressures developed during actual operation.

It can be appreciated that if the oil is too heavy in body, it may not pump readily throughout the system. There may also be the possibility of congealment within the bearing clearances and on the cylinder walls to cause difficulty in starting.

As a result, both the pour test and the viscosity must be carefully studied at the starting and operating temperatures. It is evident that a tractor oil must possess these characteristics to the proper extent. Otherwise, it may be unsatisfactory for the duty involved. Even



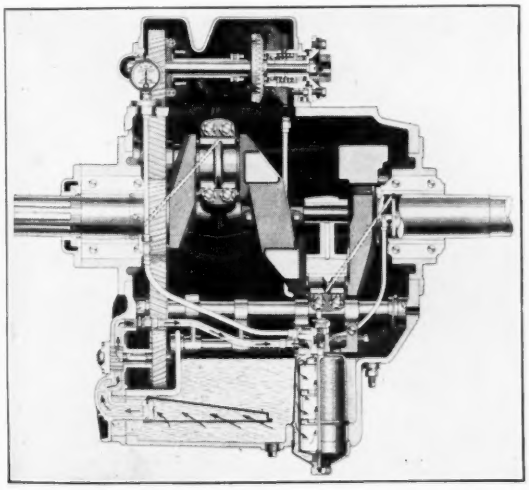
Courtesy of Oliver Farm Equipment Sales Company

Fig. 6—Working details of the Oliver Hart-Parr 18-28 Tractor. Lubrication of the engine is maintained by pressure to all main, camshaft, connecting rod, piston pin, rocker arm and governor shaft bearings. Lubrication is maintained by a heavy duty oil pump and protected by a suitable oil filter. Means is also provided for automatic lubrication of the power transmission and speed reduction mechanisms as indicated.

perfect suitability in either one case or the other does not recommend its usage in any but exceptional instances, for an abnormally high pour test or a viscosity unsuited to the starting temperature may lead to ultimate trouble.

Relation of Viscosity and Carbon Residue to Operating Performance

The viscosity or body of an oil, as it is generally understood, is of considerable importance, especially where a tractor must function in very warm weather or under intensive operating conditions. The viscosity may often have a decided effect upon oil consumption. To realize this, it is essential to appreciate that lubrication requires the development and maintenance of a suitable film of oil on the cylinder walls and within the clearance spaces of all the bearings at the temperature of operation. Under severe conditions, these latter may sometimes approach 300 degrees Fahr., as for example when a tractor is used for threshing, and the engine must operate at a standstill. Here the cooling capacity of the radiator will be somewhat lower than where the machine is in motion. As a result of this, higher engine temperature may develop. These latter improve combustion of the fuel. It is important to remember, however, that the operating viscosity of the oil will also be affected. It must be sufficient to enable the development and

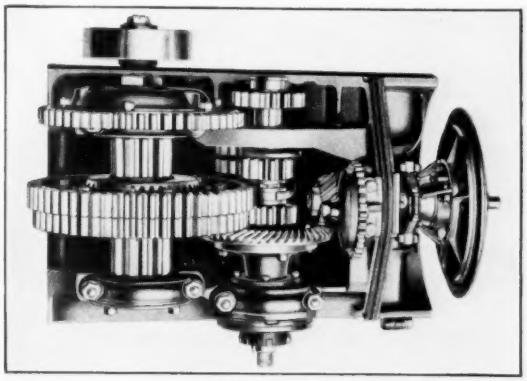


Courtesy of Deere & Company

Fig. 7—Details of the engine in the new John Deere Model D Tractor. Full force feed lubrication is maintained by a positive gear driven pump. Flow of oil is in part indicated by arrows. Location of the oil filter in the bottom of the crankcase is an adjunct to cleaning.

maintenance of adequate lubrication under these temperatures, otherwise the oil may become entirely too fluid.

The utmost care must, therefore, be taken in the selection of the proper grade of tractor oil especially for warm weather operation. Haphazard choice may be the forerunner of too great a reduction in the fluidity of the oil in service, with oftentimes ineffectual lubrication of certain of the wearing parts of the engine



Courtesy of The Massey-Harris Company

Fig. 8—Gear case on the Massey-Harris tractor. Anti-friction bearings are largely used in this installation. Adequate provision is made to enable this unit to run in a bath of oil free from leakage or possibility of entry of contaminating foreign matter.

as well as abnormal increase in the rate of consumption.

The ultimate occurrence of scored or burned out bearings, of abnormal wear on cylinder walls, and an excess of oil pumping past the piston rings, will all lead to increased cost in maintenance and a natural decrease in power output.

The Effect of Carbon Residue

Petroleum products are hydrocarbons; as a result, carbon in some chemical form must pass through every automotive engine. It is only a detriment, however, in the form of soot or deposits of carbonaceous tarry matter, which may result from evaporation.

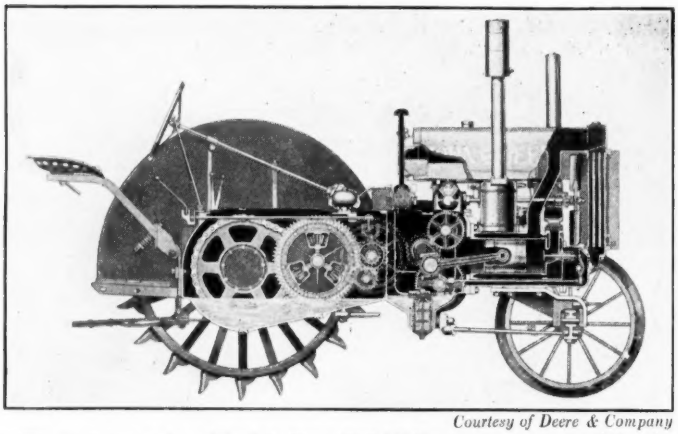
Carbon residue may have a very decided effect upon the operation of the engine, the amount of power developed and the amount of "knocking," according to the extent to which deposits are formed on the spark plugs, pistons, cylinder heads, around the rings, or on valves and valve seats.

Heat and Base of Crude

The amount of carbon residue developed will depend entirely upon the degree of heat present, the extent of refinement of the lubricant and the crude from which it is made. From particular types of crude, for example, distillates can be produced which will show an almost negligible carbon residue, 0.05 being a fair idea of the amount to be expected. The use of residual oils, however, for the purpose of blending and increasing the viscosity may raise the

carbon residue percentage of the resultant product to one per cent or above.

Carbon which is developed from blended oils containing residual products will, unless these latter are specially refined, be harder and more abrasive than carbon residue from lubricants of equal viscosity, but which are wholly of a distilled nature. Hard abrasive carbon does its greatest damage as a promoter of wear on cylinder walls and bearings. Very frequently it will be developed on the upper part of the cylinder walls to be retained by the lubricating film and ultimately worked past the piston rings and into the lubricating system.



Courtesy of Deere & Company

Fig. 9—Cutaway view of the John Deere Model D Tractor showing in detail the relative location of all operating parts and provision for automatic lubrication by enclosing same in a dust-proof case. It is interesting to note that the engine is located horizontally and that power is delivered in a straight line.

All true carbonaceous deposits in the average automotive engine do not, of course, originate from the lubricating oil. Incomplete combustion of the fuel, or an abnormal amount of dilution of the lubricating oil will also tend to increase the amount of carbon formation in the combustion chamber.

Furthermore, the lighter the lubricant or the thinner the film on the cylinder walls, the more readily will it splash or succumb to the wiping effects of the piston. This will, of course, increase the possibility of pumping or forcing of the lubricating film up into the combustion chamber, where it will ultimately be burned. The direct result is the development of more or less carbon.

How extensive these deposits may be will depend upon the residual carbon content of the oil. Where the latter burns cleanly the amount of such deposits will be relatively small. Furthermore, if the oil is properly refined and adapted to the purpose, such carbonaceous matter will be soft in appearance, low in quantity and easily removed when cleaning is necessary. Over extended periods of operation, however, carbon deposits, whatever their nature, will be bound to increase.

How Excess Lubricating Oil May Act

Just how an excess of lubricating oil may cause abnormal carbon deposits will be of interest. Theoretically, a very small amount of oil is necessary to maintain the requisite lubricating film on the cylinder walls and serve the respective bearings; actually, however, a considerable excess of oil will be used. Where the rings give the proper degree of seal and the cylinder walls are not abnormally worn, but little of this oil should pass to the combustion chamber. If the oil level is carried too high, however, especially in oiling systems involving splash lubrication, the amount of oil on the cylinder walls may be so excessive that a certain percentage cannot help but find its way into the combustion chamber. This will frequently be indicated by a smoky appearance of the exhaust.

Power Transmission Gearing

The transmission of power from the engine to the rear axle and wheels requires certain speed change and reduction gears in the tractor, as in the automobile. The transmission located between the engine and the differential, or final drive, in the average machine of this type serves the purpose by means of an arrangement of gears, or a frictional transmission device.

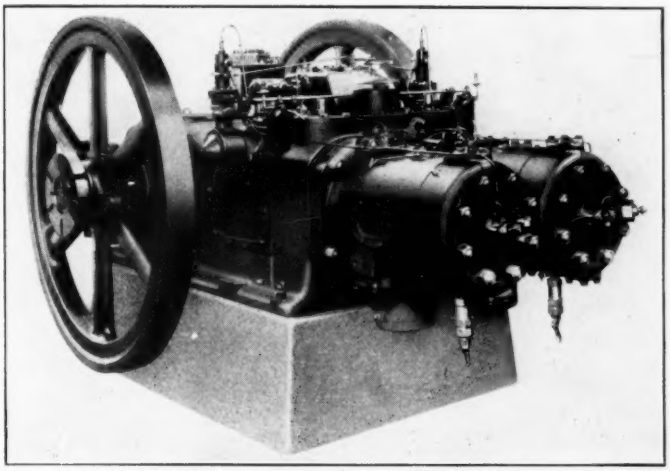
From a lubricating point of view the geared transmission requires more consideration, inasmuch as both gear and bearing lubrication is involved. In the frictional transmission there are no gears. The final drive or differential of both, however, involves the use of worm, spur, bevel or annular gears.

Transmission and rear axle lubrication is essentially a matter of combined gear and bearing lubrication, wherein the lubricant must serve a dual purpose. In the majority of tractors today the transmission is enclosed in an oil tight casing and bath lubrication is made possible. When the tractor is in motion the service on both gears and bearings is very severe, so a lubricant must be used of just the right viscosity or body to not only insure adequate penetration throughout all the bearings and to furnish the requisite oil film with a minimum of internal friction, but also to protect the gear teeth from wear and to reduce noise during operation. In the geared transmission power is usually transmitted through two distinct gear reductions.

In view of the above, there is a certain amount of latitude relative to the viscosity or body of the lubricant, which should be used in

a geared transmission. The controlling elements are the type of bearings and constructional conditions involved. Where installations are equipped with anti-friction bearings on the gear shafts a straight mineral tractor oil, ranging in the neighborhood of from 500 to 750 seconds Saybolt at approximately 100 degrees Fahr., will often give the best results.

Others, wherein similar bearings are used, but so located that individual lubrication is possible, will frequently require grease lubrication of the bearings, the gears in turn being served by a straight mineral gear lubricant of from 100 to 200 seconds Saybolt viscosity at 210 degrees Fahr. Still other installations, on account of design, wear or arrangement of gears, may require an even heavier lubricant.



Courtesy of The Cooper-Bessemer Corporation

Fig. 10—Showing the Cooper-Bessemer Type GAW 110 HP 2-cycle Diesel Engine. This engine is specially designed for the heavy duty involved in irrigation operations. It is unique by the reason of the fact that Timken Roller Bearings are used in the mounting of the crankshaft. It is claimed that these contribute to high overall mechanical efficiency and quick pick-up. Note location of the force feed lubricator which is provided to serve the cylinders.

Oil Level Important

Where using heavier gear lubricants, the gear case should never contain more than just enough to insure that the teeth of all gears on the lowest shaft of the transmission will dip in the lubricant. This will promote the most effective lubrication; any increase in the amount of lubricant in the case will impose a certain amount of "drag" on the gears, especially in cold weather. Where slow motion is involved, however, some authorities disregard "drag" and recommend that the level of the lubricant be raised until certain of the higher gears are submerged.

In this connection it is interesting to note that the builders of one type of extensively used tractor, wherein the transmission and rear axle are lubricated from the same oil bath located in the transmission case, have urged that the oil level be inspected twice a day, and that fresh oil be added when the machine is warm. When this latter is necessary the oil should be poured in to the level of the filler cap hole. Care should be taken to see that all parts have been reached by this oil before the cap is replaced.

The Final Drive

While the final drive and differential may include spur gears, internal gears, chains, worm or bevel gears, according to the design of the machine, the spur gear predominates today.

Where the chains or gears operate exposed it is necessary to use a gear lubricant of considerable viscosity to take up the shock and strain so often incurred, which would squeeze any lighter lubricant out from between the gear or sprocket teeth. Wear and deterioration will be bound to occur through the use of lighter oils or greases, as these would only drip off prematurely.

In driving chain lubrication the lubricant must again serve as a lubricant and as a protective agent. Every care must therefore be taken to saturate wearing parts thoroughly to insure penetration of the lubricant to the innermost elements. For this purpose a straight mineral lubricant having a viscosity of from 500 to 1,000 seconds Saybolt at 210 degrees Fahr., will be best suited. This should be applied hot, preferably by removing the chains and immersing them in a pail filled with the lubricant. They can then be hung up to cool and drain off excess lubricant.

Grease Lubricated Parts

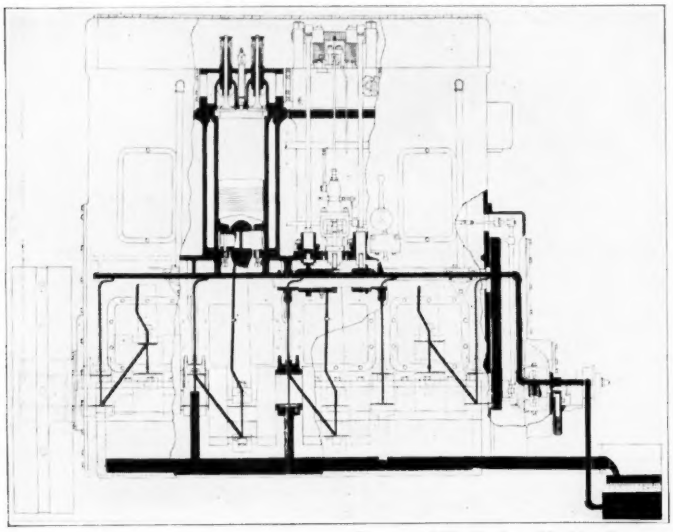
In view of the fact that certain of the external parts of some types of tractors can be lubricated quite as effectively with grease as with oil, depending upon the means of lubrication provided, it is advisable to study this matter carefully.

The use of grease as a lubricant on the average tractor will be confined to those parts which would normally be known as chassis parts on the automobile. It is becoming more and more customary to provide these parts, which include the bearings of the axles, fan, link pins, rollers, and the steering mechanism with means of pressure grease lubrication, by use of a hand or power gun, although the compression grease cup, of course, is still used.

With the exception of the front and rear wheels, which are equipped with ball or roller

bearings, the above parts will in general comprise plain or sleeve type bearings.

It is important to keep these elements properly lubricated if the tractor as a whole is to function as an efficient unit. The requirements involved in a grease for such service are not so exacting as in the case of engine oils. On the other hand, one should not go to the extreme in the belief that any cheap grease will suffice.



Courtesy of The Buckeye Machine Company

Fig. 11—Line sketch showing lubrication system of the Buckeye Diesel Engine. This is designed to afford complete pressure lubrication of the entire unit. Flow of oil is maintained by a rotary gear pump driven from the governor end of the engine which draws oil from a sump and forces it under pressure to a header where leads are taken off and run to each main bearing.

Adequate protection will be attained if the essential characteristics of a grease, such as its melting point, consistency and the nature of the soap from which it has been made are studied in connection with the operating conditions.

As a general rule, some of the bearings will be exposed at the ends, allowing for a complete flow of grease through the clearance spaces. If the grease is of the proper consistency to remain in position at such points a protective collar will be developed which will very effectively prevent entry of dust or dirt into the adjacent bearing spaces.

Influence of Pressure and Speed

In tractor service greases are chiefly of advantage in lubricating the normally slow speed elements, wherein high pressures may be involved, and a comparatively thick film of lubricant is desirable.

Stability must be given very careful consideration, for it is most important that a grease retain its intended homogeneity of mixture throughout its entire life. It must be remembered that unless a grease has been skillfully and scientifically mixed, and the highest grades of ingredients used, there may be a tendency towards some separation of oil from the soap constituent. Such an occurrence will be especially likely if the grease is stored over any length of time, or subjected to comparatively wide temperature variations. It will, of course, lead to impaired lubrication.

Means of Grease Lubrication

While the compression grease cup is still rather extensively used on some types of external wearing parts of certain tractors, it is being supplanted by the pressure gun fitting by many builders. Both, however, involve much the same principles of operation, although by means of the latter there will be more assurance of a bearing being continually and completely filled with fresh, non-contaminated lubricant. At the same time, the act of re-lubrication insures expulsion of old grease and any contaminating matter which it may have absorbed.

The compression grease cup supplies grease to a bearing by virtue of a certain amount of pressure, which is exerted upon the grease by means of a screw-down cap. While pressure is essentially the means of delivering grease to a bearing, the actual distribution within the clearance space may be aided by the motion of the moving element, capillary action, heat and vibration during operation.

Pressure Lubrication

Lubrication by means of the grease gun requires the use of some form of raised fitting or nipple equipped with a ball check valve to insure retention of the lubricant. By constructing the exterior of this fitting to conform with the design of the discharge nozzle of the pressure gun, it is practicable to render lubrication virtually automatic, and absolutely controllable upon attachment of the gun.

Pressure lubrication of this nature is comparatively simple for it facilitates the handling of grease in a cleanly and expedient manner. To attain a maximum of economy, however, it will be necessary for the operator to have a clear understanding of the constructional details of the equipment involved and the capabilities of grease as a lubricant.

The principle involved is largely that of periodic renewal of the lubricant by means of adequate pressure commensurate with the consistency of the former. Re-charging of

certain bearings with grease in this manner should be controlled or regulated by the flow from the ends of the bearings. In other words, grease is forced through the clearance spaces until a fresh film or emmission appears at the furthermost exterior parts of the bearings.

Such a condition facilitates the matter of grease lubrication by indicating when bearings have had enough, and also it enables the ready forcing out of deteriorated, contaminated or gummed grease, which otherwise would be a decided hindrance to effective lubrication. This is, in fact, one of the essential advantages of grease lubrication by means of pressure lubricators.

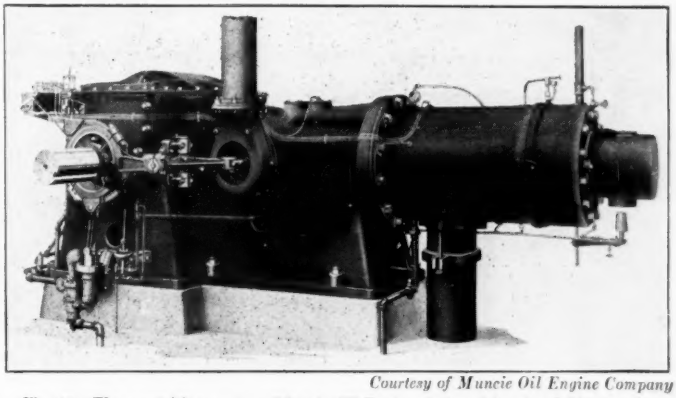
DIESEL LUBRICATION

Diesel lubrication in rice field operations must be studied from the angle of the effect of wear on power output, for this latter must be as uniform as possible if pumping efficiency is to be maintained in accordance with irrigation requirements.

It can be readily appreciated that the severe service conditions prevailing in a Diesel engine lubricating system will result in breakdown of inferior or unsuitable products. This is usually manifested by the precipitation of gummy deposits, although these are not always easily detected and the oil may still appear to be in fairly good physical condition. Gummy deposits are most dangerous when they lodge within the oil pipes leading to the bearings, or the oil ducts within the crankshaft or the connecting rod. The accumulation of such deposits may not be observed until sudden restriction or stoppage of oil to some bearing or group of bearings occurs, with resultant scoring and possible serious consequences.

In the operation of the Diesel engine the most successful way to extend the life of the bearings and cylinder liners is by means of proper lubrication and the use of properly refined oils. It is important to remember, however, that this will only hold true just so long as there are no structural imperfections which may be the original cause of wear, and which cannot be remedied by means of lubrication. Other things being equal, wear will decrease according to the extent to which the rubbing surfaces are separated by a suitable lubricating film. As a general rule, by virtue of the nature of their construction and operation, such separation of wearing surfaces can be more readily accomplished in bearings than in the other wearing parts.

Bearings permit of a more complete realization of perfect lubrication than cylinders, which at best are completely lubricated in the coolest portions only, and ordinarily are separated from the piston rings by a very thin and sometimes impaired oil film.



Courtesy of Muncie Oil Engine Company

Fig. 12—The special heavy duty Muncie Oil Engine designed for rice field operations. Note location and installation of the 7-feed McCord Force Feed Lubricator. Three of these feeds go to the cylinder, one to the piston pin bushing, one to the crank pin bushing, and two to the main bearings.

It is important to remember, however, that no matter how good a lubricant may be or no matter how judiciously it may be applied, it cannot materially reduce excessive wear which may be the result of structural or mechanical faults. As yet, designing engineers have failed to completely develop all the exact causes of excessive wear. In consequence, the nearest approach to a general solution of the problem is to give adequate consideration to the possible effects of wear on all the mechanical parts involved.

It is generally agreed upon by operating as well as designing engineers that cylinder wear especially is dependent upon the nature of combustion and the quality of the fuel. Piston and piston ring design, materials of construction, as well as the pressures and temperatures existing within the cylinders, will likewise have definite effects on wear. For an engine possessing a long working stroke, the position of the oil feeds for cylinder lubrication is also of considerable importance.

Pistons and Piston Rings

Piston and piston ring design may have a decided influence on cylinder liner wear. Current practice places the first ring quite some distance below the top of the piston. The reason for doing this is to give the gases that may pass this ring a chance to cool off somewhat, thus decreasing the temperature at the most likely point of maximum wear.

The vertical clearance allowed for the rings also seems to be a contributing factor. Too small clearance results in undesirable restraining of the rings from their natural motion.

Too small end clearances may also cause the rings to expand longitudinally on heating, and perhaps to buckle. Excessive clearance on the other hand, is thought to permit the full gas pressure to get behind the rings and thus increase wear.

But if some wear of the cylinders is due to the eroding action of the hot gases, it is reduced by the expedient of placing the first ring at quite some distance from the top of the piston. In many cases, this distance will correspond to one-quarter of the piston diameter. The required number ordinarily becomes larger as the size of the piston is increased, primarily due to the difficulty encountered in fitting the rings.

Spacing of the first ring away from the top of the piston will bring it closer to the cooling medium and further away from the flame, thus permitting it to be better lubricated. This should reduce the tendency toward gumming and insure better seal for the gases, and general increase in life. Excessive wear, however, may also be due to poor liner material. The best material to be used generally is the result of actual trial over long periods, and metallurgical research. No definite material has yet been universally employed.

Wear of liners and rings is also affected by engine cooling, lubrication and the quality of combustion. While in the smaller size engines the pistons are sufficiently cooled by the inrushing air for combustion, there seems to be a definite size beyond which additional cooling has to be provided in some form.

Bearing Lubrication

Wrist pins, crank pins, main bearings and crosshead guides of Diesel engines require careful lubrication. With the possible exception of the wrist pins which are contained in an enclosed position and subjected to considerable unradiated heat, the above parts will, in general, involve no difficult lubricating problems. Pressures are usually high, clearances low and operating speeds frequently high; yet the circulating force feed oiling system, the mechanical lubricator, or the principles of splash lubrication (in the enclosed crankcase engine) are all readily adaptable.

On large engines oil circulation under presure is preferred by many authorities. In effect it is probably the most dependable means of lubrication in that it furnishes a continuous stream of oil to the bearings, and the oil feed to each part can be independently controlled. It also assures an adequate oil film, assists materially in cooling and is capable of being connected with a filtration or purification system. This will assist in the delivery of practically pure oil, thereby eliminating the possibility of clogged oil ways.

One oil is generally used for all bearings of a Diesel engine; it should be selected to suit those bearings subjected to the most severe operating conditions. With the mechanical lubricator it is possible to bring about both cylinder and bearing lubrication by keeping the requisite lubricants in separate compartments, although where but one grade of oil is required this would not be necessary. With more than one grade there is, however, always a possibility of these being mixed up and for this reason many authorities insist that separate lubricators be used under such conditions.

Detriments of Excessive Carbon Accumulation

While dust, dirt and abrasive foreign matter in any lubricating oil may, of course, lead to accumulation in the oil passages and perhaps to stoppage as mentioned above it is also important to remember that if an oil is used which shows comparatively high Conradson carbon residue by test, a certain amount of carbon may also be developed which may lead to the same results. This carbon in an internal combustion engine may be of a comparatively hard nature or it may be produced in the shape of dust. In connection with cylinder lubrication the former will have more tendency to remain within the engine, for the lighter fluffy carbon will be more easily carried out by the exhaust.

Elsewhere in the engine it is important to remember that carbon is a poor conductor of heat, therefore when it has accumulated around the piston rings or adjacent to same, it may become heated above the temperature of the cylinder walls. This condition ultimately may be hazardous if allowed to continue. Furthermore there will be the possibility of accumulation developing on the valves and the valve seats and in the ends of the cylinders. This may cause the valves to leak, and perhaps scoring of the cylinders.

In the interest of continued and positive operation of the Diesel engine in rice field irrigation work it is therefore very important to study the lubrication requirements of the particular engine involved, the builder's recommendation in regard to means of lubrication and the lubricating ability and physical tests on the oils under consideration. While viscosity is distinctly important as an indication of the ability of any oil to maintain a lubricating film of suitable thickness under operating conditions, it is probably most essential for the operator to consider the Conradson carbon test with a view to keeping his engine as clean as possible, and extending the periods between overhaul.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.,
72 Washington St., N. Y. C.